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EVALUATION OF BAFFIN BAY NARWHAL HUNT SUSTAINABILITY

Narwhal (Monodon monoceros) by R. Phillips.

Figure 1. Approximate boundaries of Canadian summering aggregations of narwhals: A - Somerset Island, B - Admiralty Inlet, C - Eclipse Sound, D - East Baffin Island, E - Northern Hudson Bay. Other areas where narwhals are known to occur in summer: F - Parry Islands, G - Jones Sound, H - Smith Sound).

Context:

Fisheries and Oceans Canada (DFO), in close collaboration with co-management partners, is currently developing an Integrated Fisheries Management Plan for narwhals.

Narwhals are listed on Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). This science advice will inform Canada's non-detriment finding for narwhal, which has to include a scientific assessment of the sustainability of harvests.

This Science Advisory Report is from the May 10-11, 2012 review of stock identification, abundance, hunt sustainability, and tracking and movements of Canadian narwhal. Additional publications from this process will be posted as they become available on the DFO Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

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SUMMARY

- Scientific surveys conducted in various areas of the Canadian High Arctic from 1996 to 2010 indicate that the summer range of narwhals is vast and approximately 90,000 individuals compose the Baffin Bay population.
- Genetic and contaminant analyses, preliminary stable isotope analyses, satellite tracking, and Traditional Ecological Knowledge (TEK) indicate that the Baffin Bay population is composed of at least four summering aggregations: Somerset Island, Admiralty Inlet, Eclipse Sound, and East Baffin Island.
- Recommended harvest levels for each summering aggregation are based on the Potential Biological Removal (PBR) calculation and are presented as Total Allowable Landed Catch (TALC). These TALCs are conservative, and if respected should allow sustained narwhal harvests into the future.
- Within their summer range, narwhals are hunted by local communities. However, during the spring and fall migrations some Baffin Island communities harvest from a mixture of summering aggregations. To account for this, a model was developed which allocates proportions of the non-summer narwhal hunt among the different Baffin Island summering aggregations based on the most recent abundance estimates.
- The allocation model is not applicable to the Northern Hudson Bay population of narwhals as it is geographically separate from the Baffin Bay narwhals. The model is also not applicable to narwhals in the Parry Islands, Jones Sound, and Smith Sound as there is insufficient knowledge to allocate these catches at the present time.
- New tracking data indicate some exchange between the Admiralty Inlet and Eclipse Sound aggregations during the summer. The implications of this on harvest sustainability were assessed using the attribution model and the results indicated harvests are sustainable under both scenarios (i.e., separate and combined units).
- Harvest sustainability for 2011 was evaluated based on the available information and the results of the retrospective analysis using the attribution model; the conclusions are as follows:
    - There are no conservation concerns with the narwhal hunts associated with the summering aggregations of Somerset Island, Admiralty Inlet, Eclipse Sound, and East Baffin Island;
    - New tracking data indicate some exchange between the Admiralty Inlet and Eclipse Sound aggregations during the summer. Sensitivity analysis that assumed Admiralty Inlet and Eclipse Sound are one unit indicated that catches are still considered sustainable; and
    - Owing to the paucity of data available for narwhals in Parry Channel, Jones Sound, and Smith Sound, the sustainability of the narwhal hunt in these areas has not been evaluated.

INTRODUCTION

The Nunavut Wildlife Management Board (NWMB) is an Institution of Public Government, established under the Nunavut Land Claims Agreement (NLCA), which shares decision-making authority with the federal government (i.e. DFO with respect to fishes and marine mammals).

The NWMB establishes wildlife harvest levels in the Nunavut Settlement area. DFO is currently in close collaboration with co-management partners to develop an Integrated Fisheries Management Plan (IFMP) for narwhals.

Narwhals are listed on Appendix II of CITES. As is required under Article IV, paragraph 2 of CITES, an export permit shall only be granted when the Scientific Authority of the State of export has advised that such export will not be detrimental to the survival of the species in the wild. This determination is referred to as a non-detriment finding (NDF) and is not subject to socio-economic considerations.

This Canadian Science Advisory Secretariat (CSAS) Science Advisory Report provides scientific advice regarding the sustainability of the Baffin Bay narwhal hunt.

ANALYSIS

Narwhal Summering Aggregations

Abundance and Delineation

Scientific surveys conducted in various areas of the Canadian High Arctic from 1996 to 2010 indicate that the summer range of narwhals is vast and there are approximately 90,000 individuals in the Baffin Bay population. Past scientific research has focused primarily on producing abundance estimates and determining stock delineation; Traditional Ecological Knowledge (TEK) has been considered when available.

Two narwhal populations are recognized in Canadian waters: the Baffin Bay population and the Northern Hudson Bay population.

Genetic and contaminant analyses, preliminary stable isotope analyses, tracking programs, TEK, and research surveys, indicate that the Baffin Bay population is comprised of at least four summer aggregations (i.e., Somerset Island, Admiralty Inlet, Eclipse Sound, and East Baffin Island) (Figure 1). However, recent tracking data from 2011 indicate mixing between Admiralty Inlet and Eclipse Sound narwhals during the summer.

Narwhals are also present in the Parry Islands, Jones Sound, and Smith Sound (Figure 1) but estimates of narwhal abundance in these areas are currently not available. Little is known about the relationship of narwhals in the Parry Islands, Jones Sound, and Smith Sound to the Baffin Bay population, as well as to narwhals in Greenland. Narwhals have been observed during the summer farther west and north of the Somerset Island summering aggregation in an area referred to as "Parry Islands". Narwhals are also present in Smith Sound and in Jones Sound; preliminary genetic analyses indicate that narwhals in Jones Sound are genetically different than those in the Somerset Island summering aggregation.

Rationale for Summering Aggregation Management Approach

Genetic, contaminant, preliminary stable isotope analyses, and behavioural differences are the basis for the current working hypothesis for managing narwhals as summering aggregations. This approach is intended to avoid the risk of local depletion and to reflect the temporal and spatial scale of the hunt, and to allow narwhals to be resilient to changing environments.

Management of species by smaller units such as sub-populations or summering aggregations is commonplace for many species, including other cetaceans and polar bears.

Sustainable Harvest Levels

Sustainable harvest levels for each summering aggregation are based on the Potential Biological Removal (PBR) method and are presented as Total Allowable Landed Catch (TALC) (Table 4). The PBR is the preferred method when data are considered to be insufficient to conduct a full assessment. The PBR takes into account various sources of uncertainty (e.g. imprecision of population size estimates, growth rate, etc.). Summering aggregations of Canadian narwhals often have only a single recent survey to assess population size or data are considered insufficient to estimate population dynamic parameters. Therefore, DFO considers the PBR the acceptable approach to estimate sustainable human-induced mortality rates at the present time. As hunting losses are difficult to quantify, average loss rates are applied to the PBR in order to calculate the TALC. Sustainable harvest levels (TALC) are conservative and if they are respected should allow sustained catches into the future until there are sufficient data (e.g. via multiple index surveys and catch records) to conduct more detailed population dynamic assessments.

Retrospective 2011 Harvest Sustainability Analysis

An allocation model (Richard, 2011), based on a spatial model of the source and degree of summering aggregation mixtures, was developed to produce solutions that optimize narwhal harvests and minimize the risk of over-exploitation of any one summering aggregation. The allocation model was developed as a tool for managers to allocate *future* narwhal harvests in order to minimize over-exploitation of any one narwhal summering aggregation. When this model is used to evaluate sustainability of harvests that have *already occurred*, it is referred to as an attribution model as it is attributing past harvest to specific summering aggregations based on the location of the hunt.

The model was applied to the summering aggregations of Somerset Island, Eclipse Sound, Admiralty Inlet, and East Baffin Island. The model is not applicable to the Northern Hudson Bay population of narwhals because it is geographically separate from Baffin Bay narwhals. In addition, there is insufficient knowledge to allocate catches of narwhals in Parry Islands, Jones Sound, or Smith Sound to specific communities at the present time.

The four summering aggregations considered in the allocation model appear to be relatively sedentary in summer and are primarily hunted in their summer range (Figure 2) by local communities as follows.

- The Admiralty Inlet (AI) summering aggregation is harvested by hunters in Arctic Bay (AB);
- The Eclipse Sound (ES) summering aggregation is harvested by hunters in Pond Inlet (PI);
- The East Baffin (EB) summering aggregation is harvested by hunters in Clyde River (C) and Qikiqtarjuaq (Q); and

- The Somerset Island (SI) summering aggregation is harvested by hunters in Resolute (RB; particularly in the Creswell Bay area), the Kitikmeot communities of Gjoa Haven (GH), Taloyoak (TK) and Kugaaruk (KK), and the Northern Foxe Basin communities of Igloolik (IG) and Hall Beach (HB). These six communities are referred to as the Western Communities and their harvest is called the "Western annual catch".

Outside of the summer, open-water season, Baffin Island communities hunt a mixture of summering aggregations (Figure 2). The proportion of narwhals belonging to any particular summering aggregation in the non-summer harvest period is unknown, but it is assumed to be proportional to the size of each aggregation relative to the total number of animals in the mixture. Risk modeling was used to evaluate the sensitivity of the modeling analyses to this assumption.

A retrospective analysis using the model was conducted for the 2011 Baffin Bay narwhal hunts to determine their sustainability (Abraham, 2013). Table 1 shows model inputs, Tables 2-3 show the results of the analyses, and a summary of the outcomes of the retrospective analysis is provided in Table 4. Harvest at the 2011 level is below the TALC for the summering aggregations included in the model and therefore can be considered sustainable.

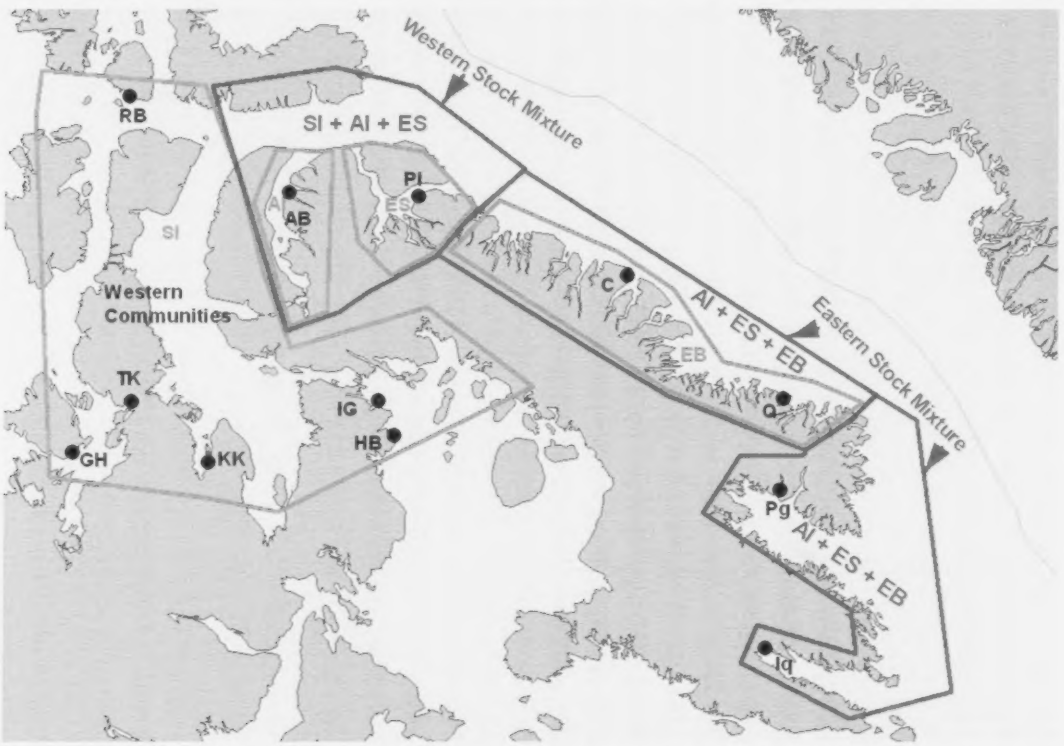

Figure 2. Schematic representation of the Baffin Island narwhal summering aggregations (in red letters: SI: Somerset Island; AI: Admiralty Inlet; ES: Eclipse Sound; EB: East Baffin Island) and of non-summer mixtures (in blue letters). Communities that hunt the summering aggregations are indicated in black letters (RB: Resolute; TK: Taloyoak; GH: Gjoa Haven; KK: Kugaaruk; IG: Igloolik; HB: Hall Beach; AB: Arctic Bay; PI: Pond Inlet; C: Clyde River; Q: Qikiqtarjuaq; Pg: Pangnirtung; Iq: Iqaluit) (Richard, 2011).

Table 1. Community attribution model inputs for 2011.

Model Inputs:		2011
1 (Western Communities total catches)		57
2 (Pangnirtung & Iqaluit total catches)		4
3 (Arctic Bay summer proportion)		0.78
4 (Pond Inlet summer proportion)		0.65
5 (Clyde River summer proportion)		0.28
6 (Qikiqtarjuaq summer proportion)		0.46
7 (community total catches)	Arctic Bay:	130
	Pond Inlet:	112
	Clyde River:	36
	Qikiqtarjuaq:	90

Table 2. Remainders of the summering aggregation Total Allowable Landed Catch (TALC) for 2011 calculated using the attribution model.

Summering Aggregation	2011
Somerset Island	438
Admiralty Inlet	88
Eclipse Sound	113
East Baffin Island	54
Total	693

Tagging data from 2010 and 2011 of Eclipse Sound narwhals indicates that some narwhals moved from Eclipse Sound to Admiralty Inlet during the summer. Considering the possibility of mixing between the Eclipse Sound and Admiralty Inlet summering aggregations, an analysis was conducted assuming these were one unit (using 2004 survey estimates for both summering aggregations). Results did not demonstrate a substantial departure from those presented in Table 2 and narwhal catches are considered sustainable (TALC-TC >0) even if Admiralty Inlet and Eclipse Sound are the same unit (Table 3).

Table 3. Remainders of the stock Total Allowable Landed Catch (TALC) for 2011, assuming that Admiralty Inlet and Eclipse Sound are one summering aggregation.

Summering Aggregation	2011
Somerset Island	429
Admiralty Inlet & Eclipse Sound	5
East Baffin Island	46
Total	480

2011 Baffin Bay Narwhal Hunt Sustainability

The sustainability of the 2011 Baffin Bay narwhal hunt was based on available information regarding population estimates, recommended TALC, current quotas/harvest limits, and harvest levels over the past six years (Table 4).

Narwhals are abundant in the summering aggregations of Somerset Island, Admiralty Inlet, and Eclipse Sound, harvests are within the TALC, and the outcomes of the retrospective analysis indicate that harvests in these areas are sustainable.

Narwhals are abundant in the East Baffin Island summering aggregation and although harvests are greater than the TALC, the results of the retrospective analysis using the attribution model indicate sustainability. This is possible as narwhals from other summering aggregations are available during the spring and fall migrations and harvests in other areas are well within the scientific advice regarding harvest limits.

The narwhal hunt in the areas of Parry Islands, Jones Sound, and Smith Sound is considered opportunistic, no population estimates exist, and a TALC has not been estimated. Narwhals in Jones Sound are harvested by the community of Grise Fjord and narwhals in Smith Sound are harvested by Greenland hunters.

Table 4. Summary of the information available for the summering aggregations of Baffin Bay narwhals.

Summering Aggregation	*Last Scientific Survey*	*Abundance Estimate*	*Scientific Advice re: Harvest Limits*[1]	*Current Quota and/or Harvest Limit*[2]	*2011Harvest Summary considered in the Attribution Model Analyses (total for all communities)*	*Harvest Attribution Model Results*[3]
Somerset Island	1996	45,358 (SE=15875; CV=25%)	PBR[1] = 681 TALC[1] = 532	Igloolik (25) Kugaaruk (45) Taloyoak (15) Gjoa Haven (15) Resolute (32) Hall Beach (10)	57	Sustainable
Admiralty Inlet	2010	18,049 (CI=11,613-28,053; CV=23%)	PBR[1] = 299 TALC[1] = 233	Arctic Bay (130)	130	Sustainable
Eclipse Sound	2004	20,225 (SE=7285; CV=36%)	PBR[1] = 301 TALC[1] = 236	Pond Inlet (130)	112	Sustainable
East Baffin Island	2003	10,073 (SE=3123; CV=31%)	PBR[1] = 156 TALC[1] = 122	Qikiqtarjuaq (90) Clyde River (50) Iqaluit (10) Pangnirtung (40)	130	Sustainable
Parry Channel, Jones Sound, & Smith Sound	Have not been surveyed	Unknown	None	Grise Fjord (20)	21	N/A

[1]PBR (Potential Biological Removal) is a method by which the Total Allowable Landed Catch (TALC) is estimated after factoring in hunting loss rates (LR). TALC is derived from the PBR as follows: TALC = PBR/(1+LR). Loss rates are derived from the community-based management reports.

[2]Quotas/harvest limits are listed by communities that are geographically associated with each narwhal summering aggregation and/or population.

[3]Certain narwhal summering aggregations are shared by communities within and also potentially shared outside of Nunavut during annual migrations. The proportion of migrating narwhals harvested in certain communities in the

spring and fall has been calculated and the sustainability of the overall harvest for affected summering aggregations has been determined.

Sources of Uncertainty

- The extent of mixing between the summering aggregations of Eclipse Sound and Admiralty Inlet is not fully understood.
- Some of the abundance estimates used in the PBR calculations are over 10 years old and new comprehensive surveys are required.
- The proportion of narwhals belonging to any particular summering aggregation in the non-summer community hunt is unknown. An assumption has been made that it is proportional to the size of each summering aggregation relative to the total number of animals in the mixture of the stocks.

CONCLUSIONS

Sustainability for the 2011 Baffin Bay narwhal hunt was evaluated based on available information, including the results of the retrospective analysis using the attribution model; the conclusions are as follows:

- There are no conservation concerns with the narwhal hunts associated with the summering aggregations of Somerset Island, Admiralty Inlet, Eclipse Sound, and East Baffin Island
- New tracking data indicate some exchange between the Admiralty Inlet and Eclipse Sound aggregations during the summer. Sensitivity analysis that assumed Admiralty Inlet and Eclipse Sound are one unit indicated that catches are still considered sustainable; and
- Owing to the paucity of data available for narwhals in Parry Islands, Jones Sound, and Smith Sound, the sustainability of the narwhal hunt in these areas has not been evaluated.

OTHER CONSIDERATIONS

The range of Baffin Bay narwhals may extend beyond the areas initially identified in the model, thus some communities that hunt the population may not be covered by this analysis. For example, 10 Baffin Bay narwhals were harvested by Cambridge Bay, Nunavut in 2011. The harvests of Cambridge Bay are assumed to be from the Somerset Island summering aggregation. Also, winter hunts occur annually in a number of West Greenland communities and the composition of these hunts has not been assessed.

SOURCES OF INFORMATION

This Science Advisory Report is from the May 10-11, 2012 review of stock identification, abundance, hunt sustainability, and tracking and movements of Canadian narwhal. Additional publications from this process will be posted as they become available on the DFO Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

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